IMPROVED PROCESSING, ANALYSIS AND USE OF HISTORICAL PHOTOGRAPHY

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Environment, Energy Security & Sustainability (E2S2) Symposium
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TerraSpectra GEOMATICS

ESTCP

US Army Corps of Engineers

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Report Documentation Page

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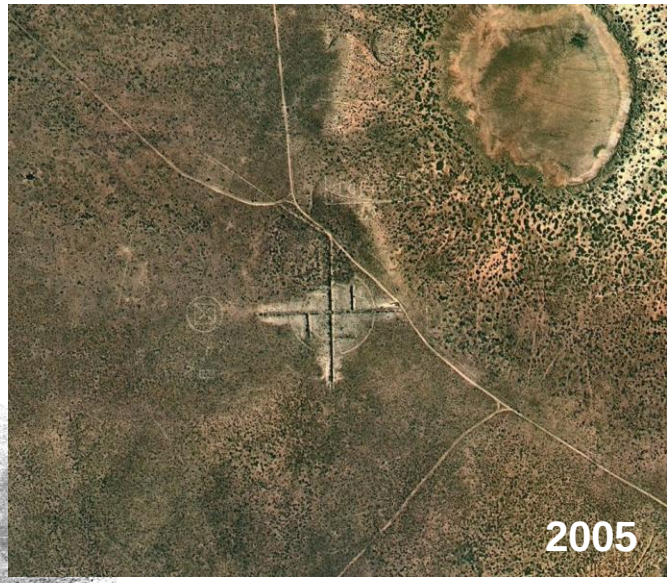
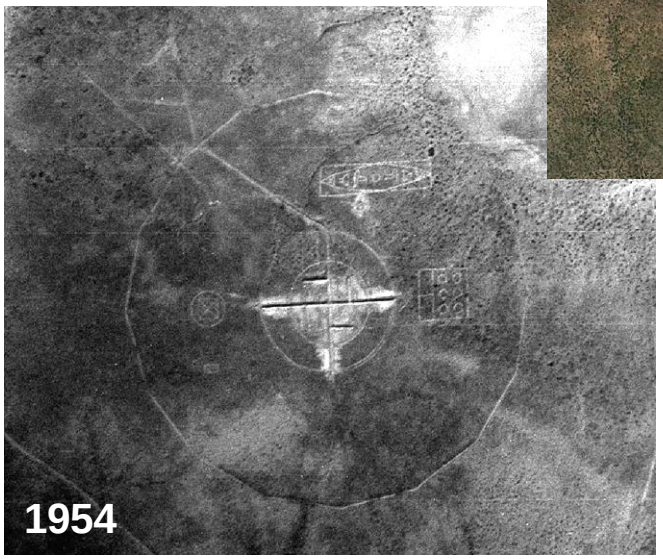
Overview

- **Problem Statement**
  - Accuracy of Range/Feature Locations (FUDS MMRP)
- **Technical Objectives**
  - Comparison of 3 Methods
- **Goals and Results**
  - 8 Test Sites
  - Validation Efforts
- **Key Observations**
  - Methods
  - Scan Resolutions
  - Photo Searches
- **Summary**





Aerial Photos of New Mexico WWII-era Precision Bombing Range (PBR)

(Unknown Site)

Historical Versus Recent

Features at some sites are distinct on historical photos but extremely faint or not visible on recent imagery

2005 Color Orthophoto

K06NM0333 - Former Guadalupe Bombing and Gunnery Range

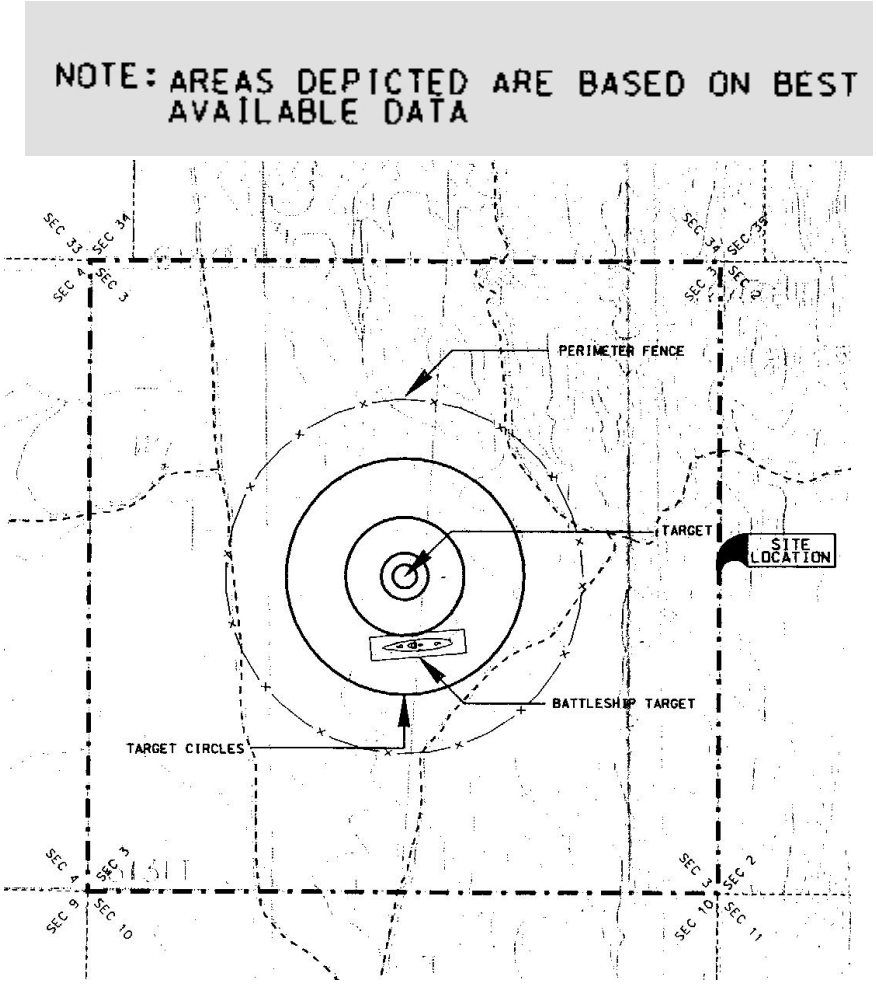
Historical Versus Recent

Features at some sites are distinct on historical photos but extremely faint or not visible on recent imagery

1950 BW Photograph

K06NM0333 - Former Guadalupe Bombing and Gunnery Range

Archive Search Reports (ASR)



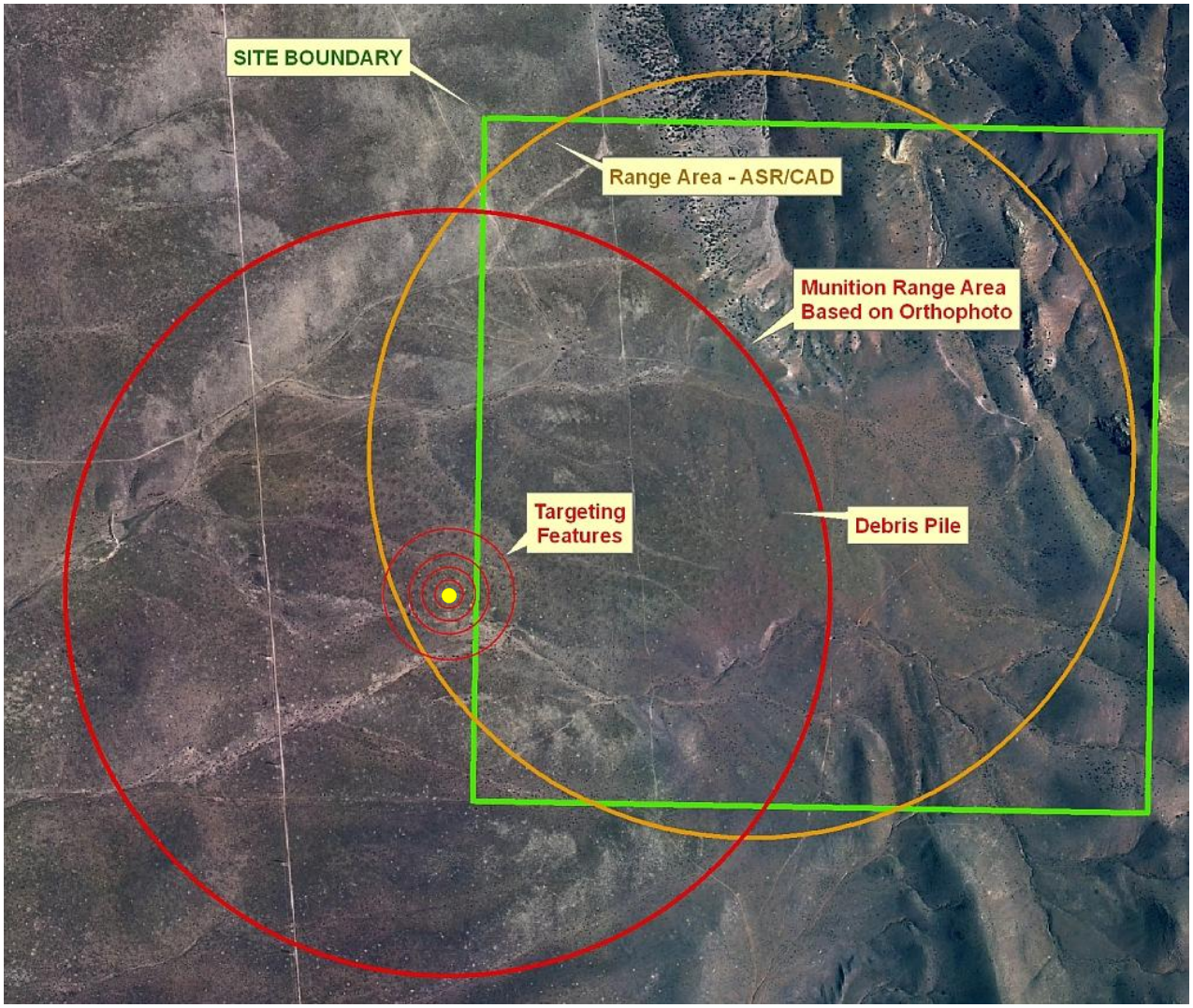
Primary Source for FUDS Property and Range Feature Data.

J11 Residue pile located at target center

Assumed "Target Center" based on 1952 photo prints and pocket stereoscope viewing

K06NM0623: KAFB PBR 22 TRGT S-9

Refinement of Range Centroid Locations via Orthophotos



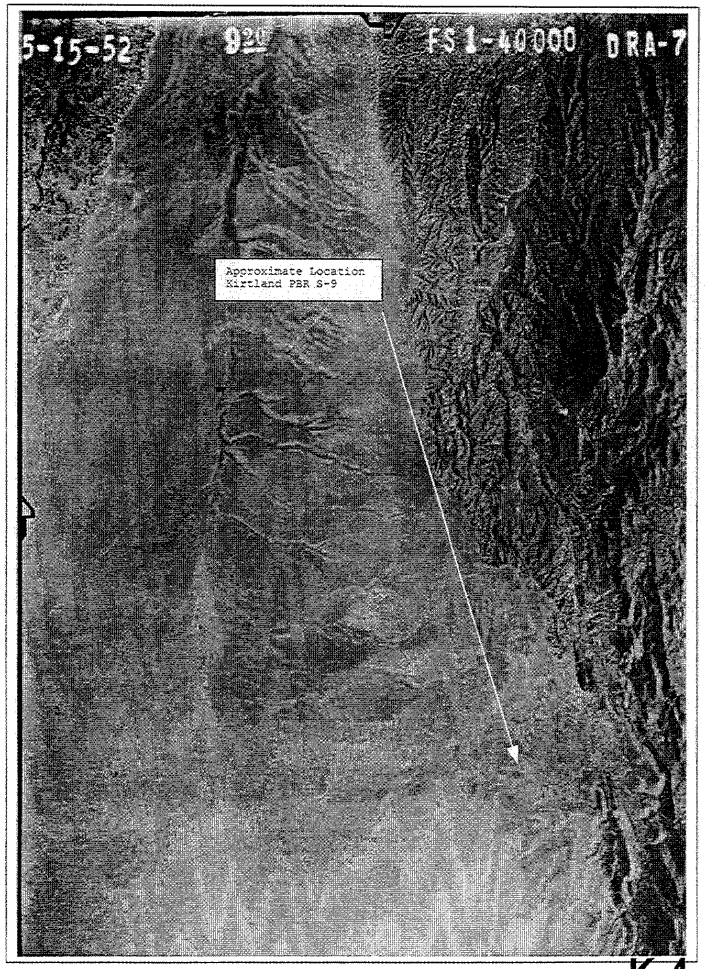
- **Over 65% of NM FUDS MMRP Range centroids showed apparent offsets >25 meters**
- **Offsets as much as 1 mile found**
- **Detailed range feature mapping, however, was *not* always possible using 2005 orthos**
- **Some ranges were not apparent on recent photos**
- **Better standard and new practices are available**

K06NM0623: KAFB PBR 22 TRGT S-9 [1 Section = 1 sq mile = 640 acres]

ASR Historical Photos

Available Archive Search Report (ASR) photos of limited use due to coarse Portable Document Format (PDF) image compression.

Analysis was conducted on print copies rather than diapositives with better resolving characteristics.



ESTCP Project Technical Objectives

- Define and demonstrate an improved set of image interpretation and geospatial analysis procedures for the more effective use of historical aerial photos
  - Emphasis upon detection and mapping of former range locations over large areas (Wide Area Assessments)
  - Secondary focus is improved site specific assessments, such as identification of target features, especially demolition bomb craters (or crater fields)

Primary Goal: Comparison of 3 Methods

1. **Existing Archive Search Reports (ASR)***

   Based on aerial photo prints and pocket stereoscopes

Pocket Stereoscope

Mirror Stereoscope

2. **Recent/Current Standard Best Practice**

   Based on diapositives (film) and stereo zoom scopes

Stereo Zoom Stereoscope

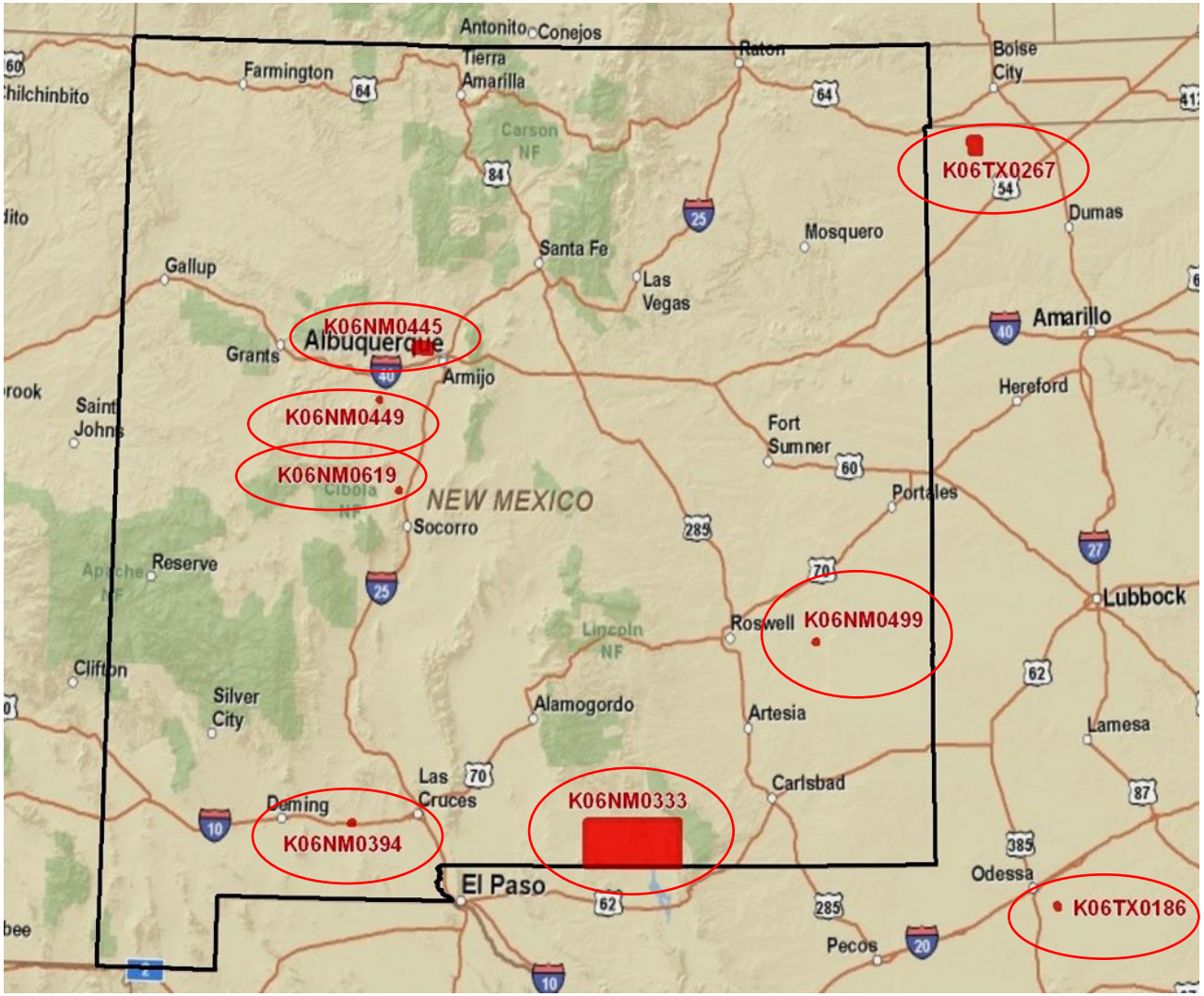
3. **Digital Image Processing**

   Based on blur removal, enhancements, and stereo viewing

Digital 3-D

* Two Preliminary Assessments (PA) and one Site Investigation (SI) reports were used in place of ASR documents where ASR documents were not available or did not include photo analyses.

6 New Mexico and 2 Texas Sites



NEW MEXICO SITES

K06NM0333 – Guadalupe Bombing and Gunnery Range 495,053 acres

K06NM0445 – Kirtland AFB PBR N1, N3, and New Demolition 15,246 acres

K06NM0394 – Deming AFB PBR #10 960 acres

K06NM0449 – Kirtland AFB PBR #S-12 640 acres

K06NM0499 – Walker AFB Demolition Bombing Range #35 1,000 acres

K06NM0619 – Kirtland AFB PBR#18 Target S-5 640 acres

Range map not available at start of the project for blue sites

TEXAS SITES

K06TX0186 – Midland AAF Target Range #14 1,646 acres

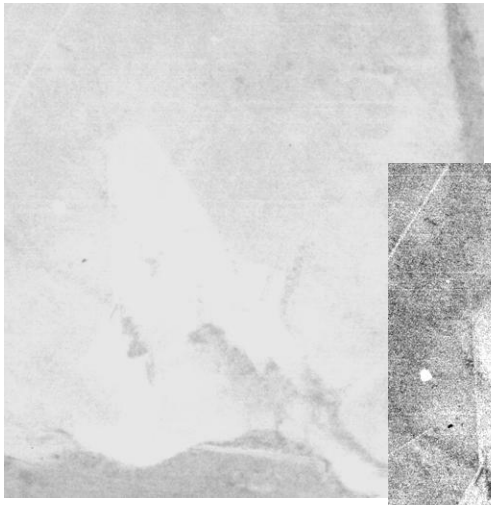
K06TX0267 – Dalhart PBR #3 and #4 16,581 acres

Comparison of Results

	Ranges (29)	Features (79)
Original ASR Photo Print Interpretations ♦ Missed and/or incorrectly located several ranges ♦ Found fewer target and navigation features	**72%**	**42%**
Photo Interpreters Using Diapositives with Zoom Stereoscopes ♦ Consistently found all but 1 ranges ♦ Usually found more target and navigation features	**97%**	**75%**
Image Analysts Using Digital Processing ♦ Consistently found all ranges ♦ Similar or slightly better results than diapositive film analyses.	**100%**	**84%**

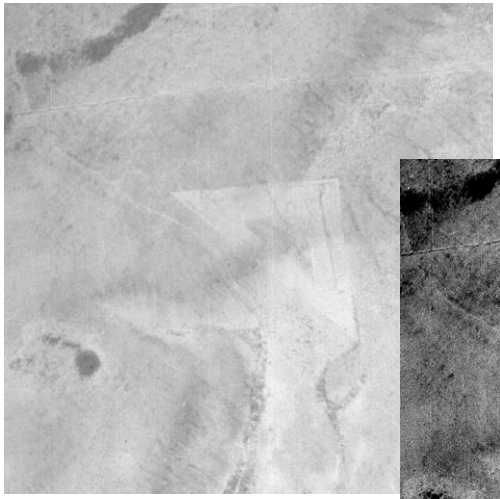
Examples of Enhancements

Standard image sharpening, brightness, and contrast enhancements proved effective.

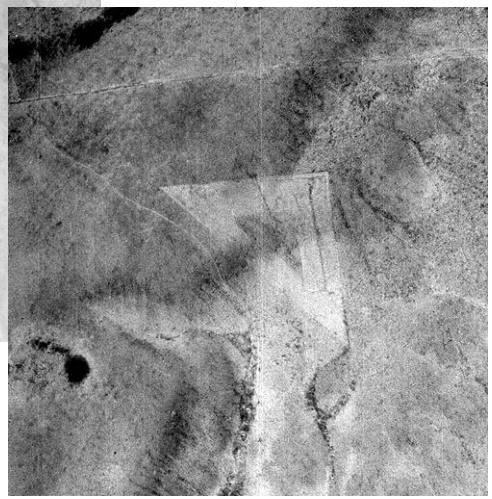


Original Photo Scan

Digitally Enhanced



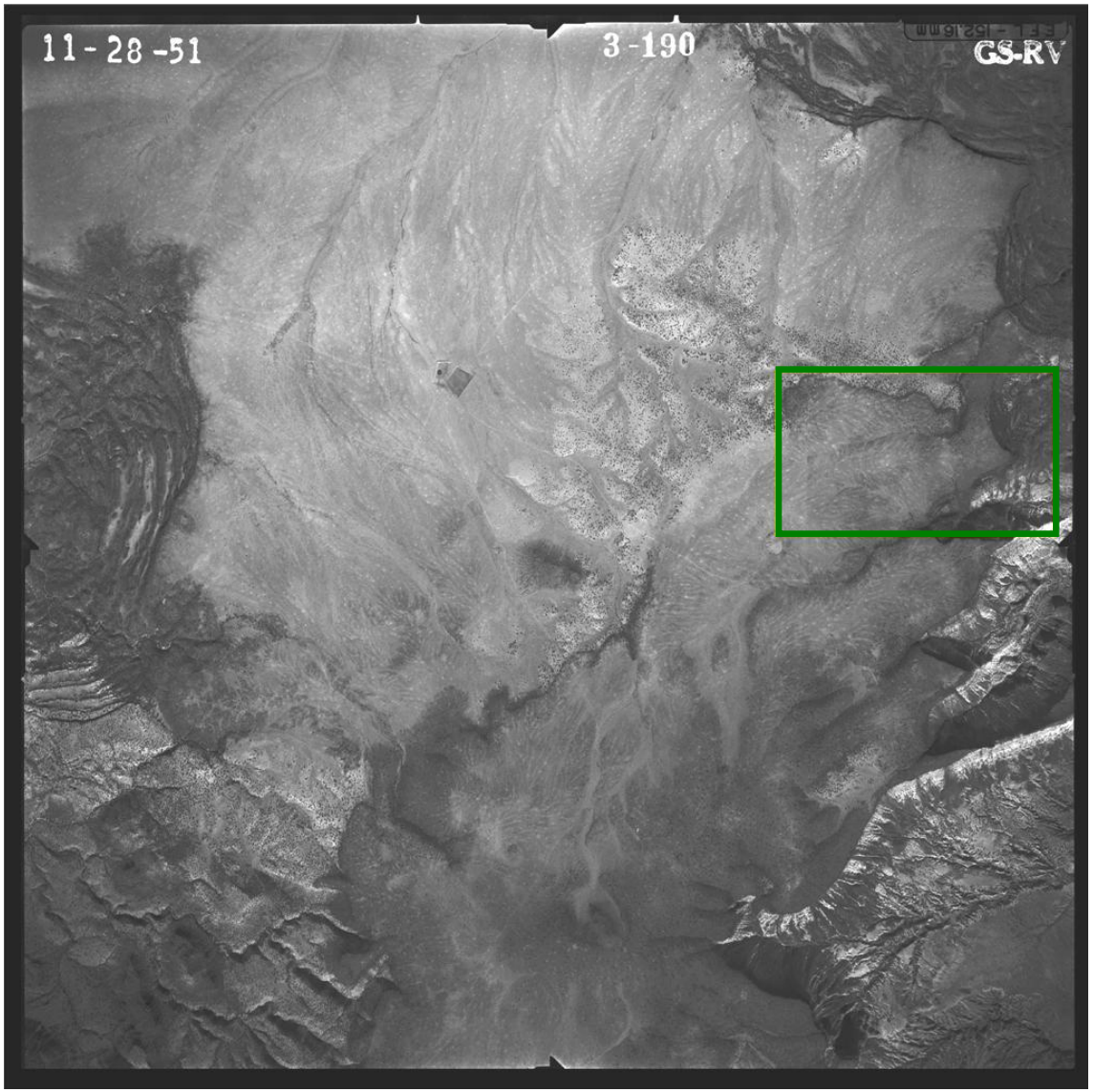
Original Photo Scan



Digitally Enhanced

Features match location and appearance of ATAGR navigation features on 1944 map included in 2008 ASR Supplement.

1951 Photo – Enlarged Area Outlined

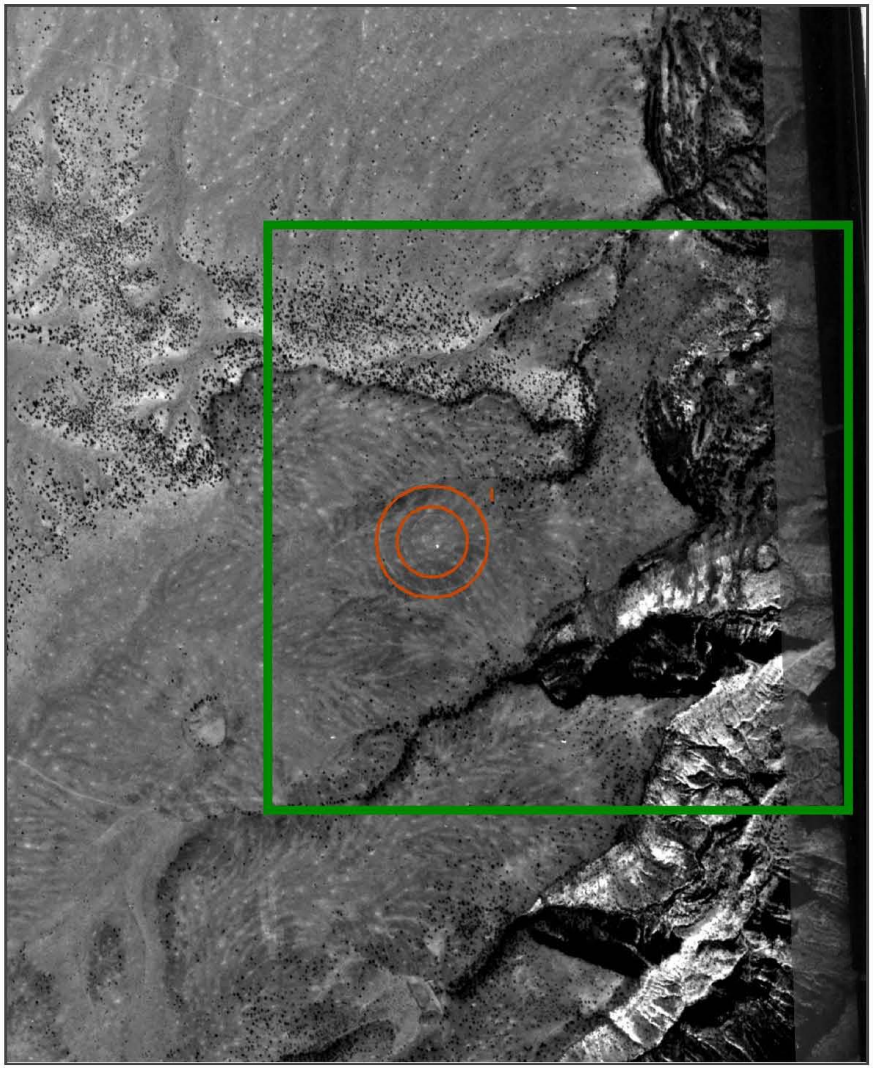


Original Photo Scale 1:28,400 (about 4 by 4 mile scene)

NOTE: Film prints or diapositive copies are no longer available from USGS-EDC

Digital scans are now their standard means for all photo products

2005 ASR Mapping – 1951 Photo



KEY TO FEATURES:

FEATURE NUMBER	FEATURE DESCRIPTION
1	CONCENTRIC RING BULLS-EYE TARGET VISIBLE AT: N 34°50'26" W 107°07'37"

LEGEND

- SITE LOCATION
- FEATURE LOCATION

0 1000 2000

APPROXIMATE SCALE IN FEET

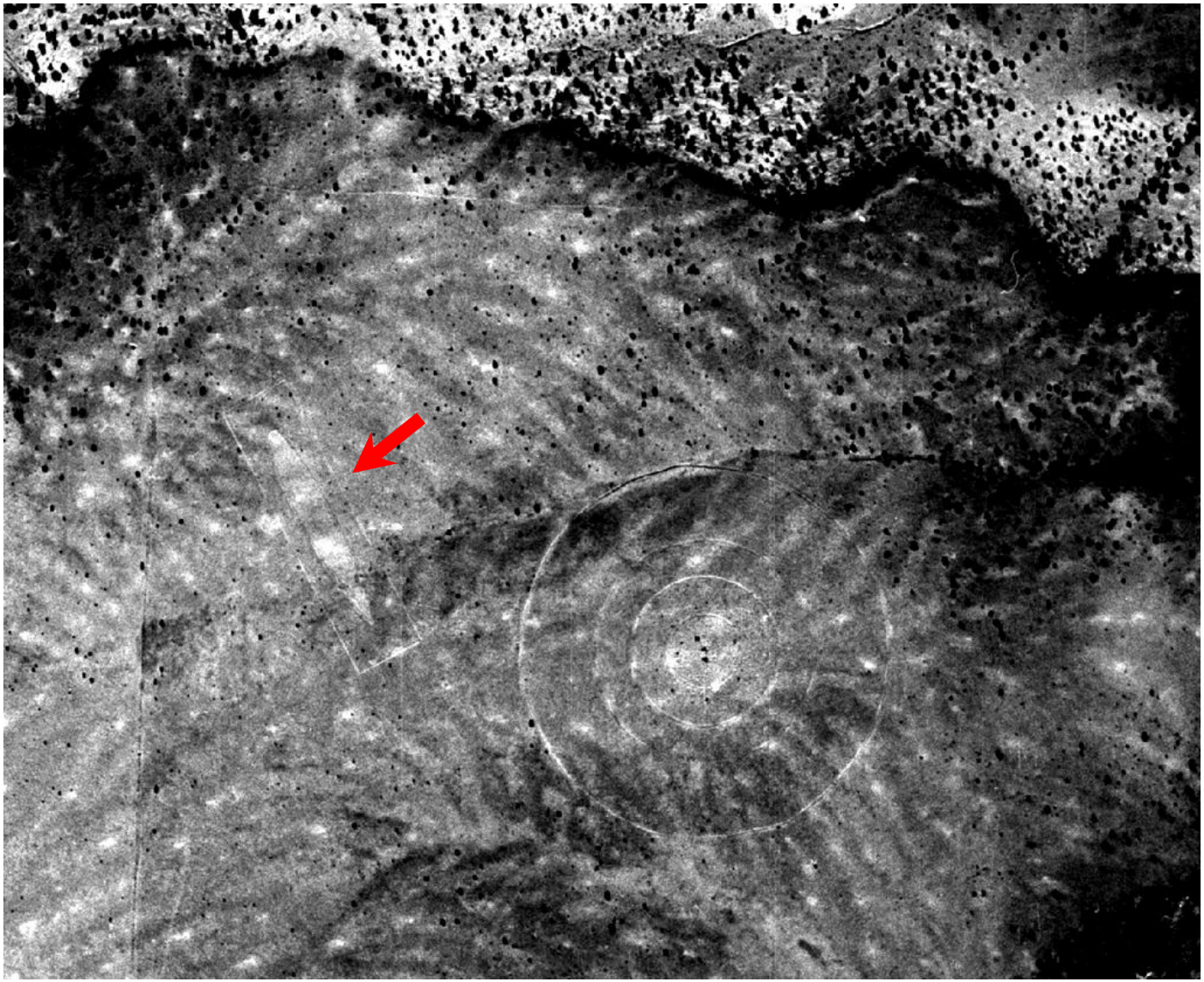
N

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

KIRTLAND PBR NO. S-12
FUDS PROJECT NO. K06NM044901
SOUTH GARCIA, NEW MEXICO
VALENCIA COUNTY
1951 AERIAL PHOTO

PROJ. DATE:	DATE OF ID YEAR	PLATE NO.
19-JAN-2005 10:56		4

Digital Enhancement of Site Area



All methods noted the target circle, but the battleship target was identified only on the digitally enhanced imagery.

Validation Efforts

- Most of the additional ranges and range features were confidently identified.
- For “probable” and “possible” feature interpretations, additional historical photos were acquired to assist the validation of interpretation results – ongoing Site Investigations (SI) also provided some feedback.
- Substantially more dates of older historical photography were identified than used in the original ASR’s.
- Additional range features were noted at several sites.

Photo Search Results – Oldest Dates

Site	Photo	Site Active	Validation Photos
K06NM0333	1950	1943-1956	1943, 1946, 1949, 1958
K06NM0394	1974*	1943-1947	1942, 1951, 1953, 1956
K06NM0445	1967*	1941-1947	1935, 1945, 1951
K06NM0449	1951	1942-1946	not considered necessary
K06NM0499	1971*	1944-1945	1946, 1954
K06NM0619	1946	1943-1946	not considered necessary
K06TX0186	1946	1942-1953	not considered necessary
K06TX0267	1954	1943-1945	1941, 1952, 1953

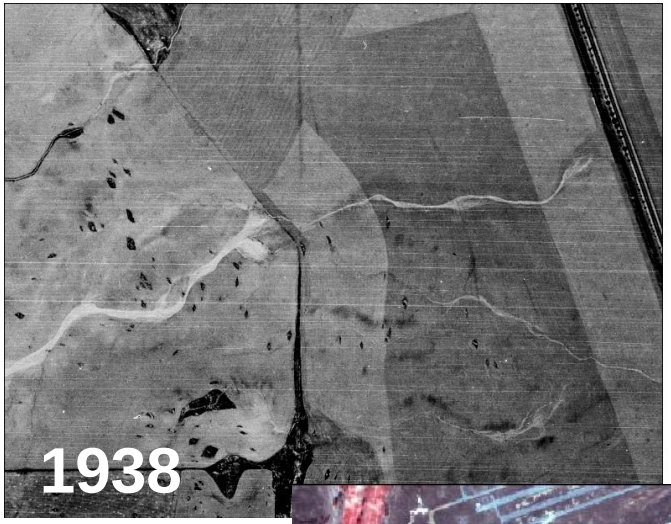
***Dates significantly later than period of activity**

Site review document dates ranged from 1994 to 2009

Example Photo Search Results

Former Camp Haan, Riverside, CA – J09CA0279

1938	1971	1988
1941*	1973	1989
1947	1974	1990
1949	1975	1991
1953	1976	1992
1958	1977	1994
1961	1978	1996
1963	1979	2003
1966	1980	2004
1967	1984	2005
1970	1985	2006
	1986	2008



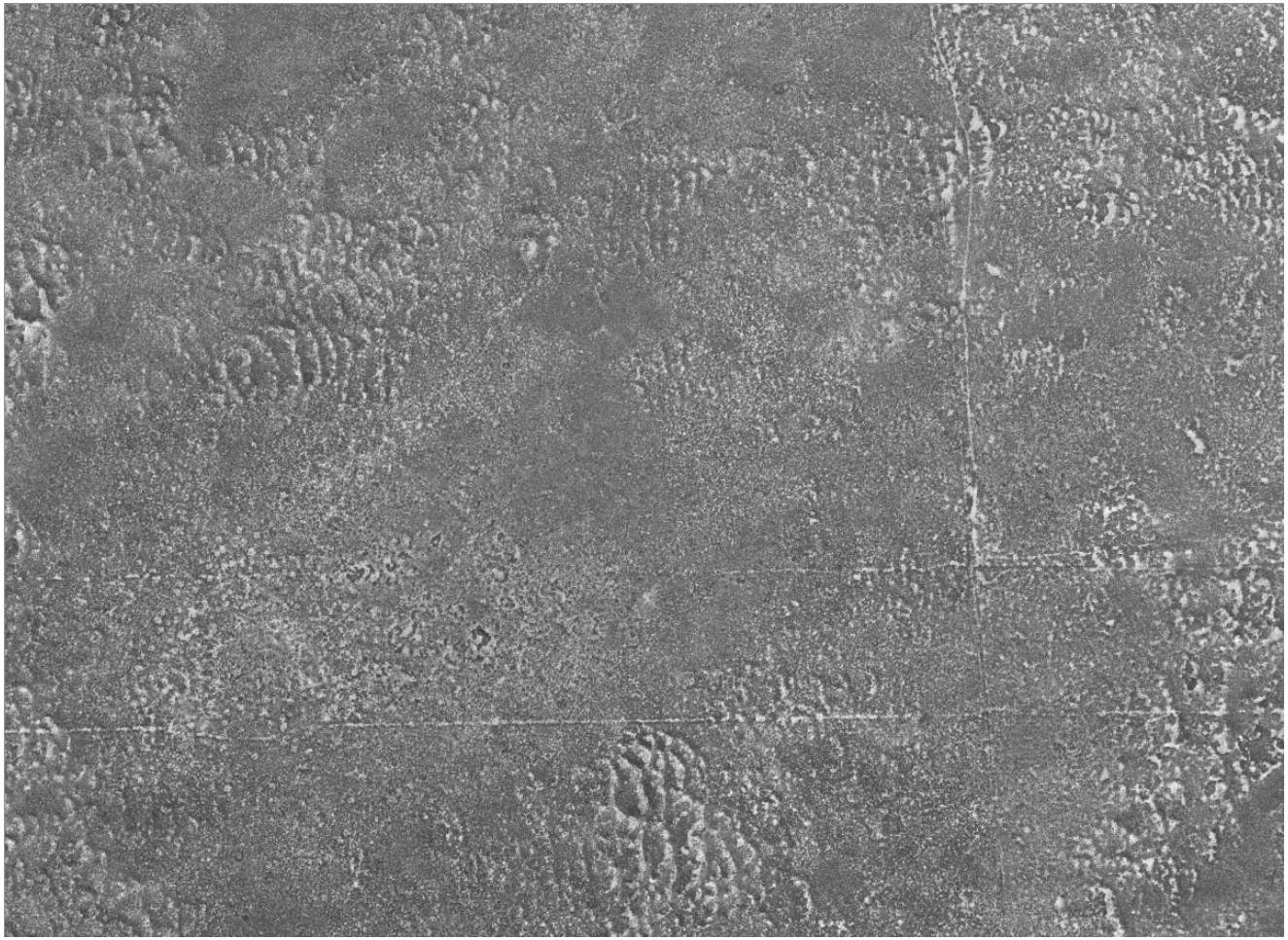
Primary Sources:

- NARA
- USGS-EDC
- USDA-APF0
- Univ. Libraries
- Private Firms
- State/Local Gov't
- Museums

* Pending DoD acquisition

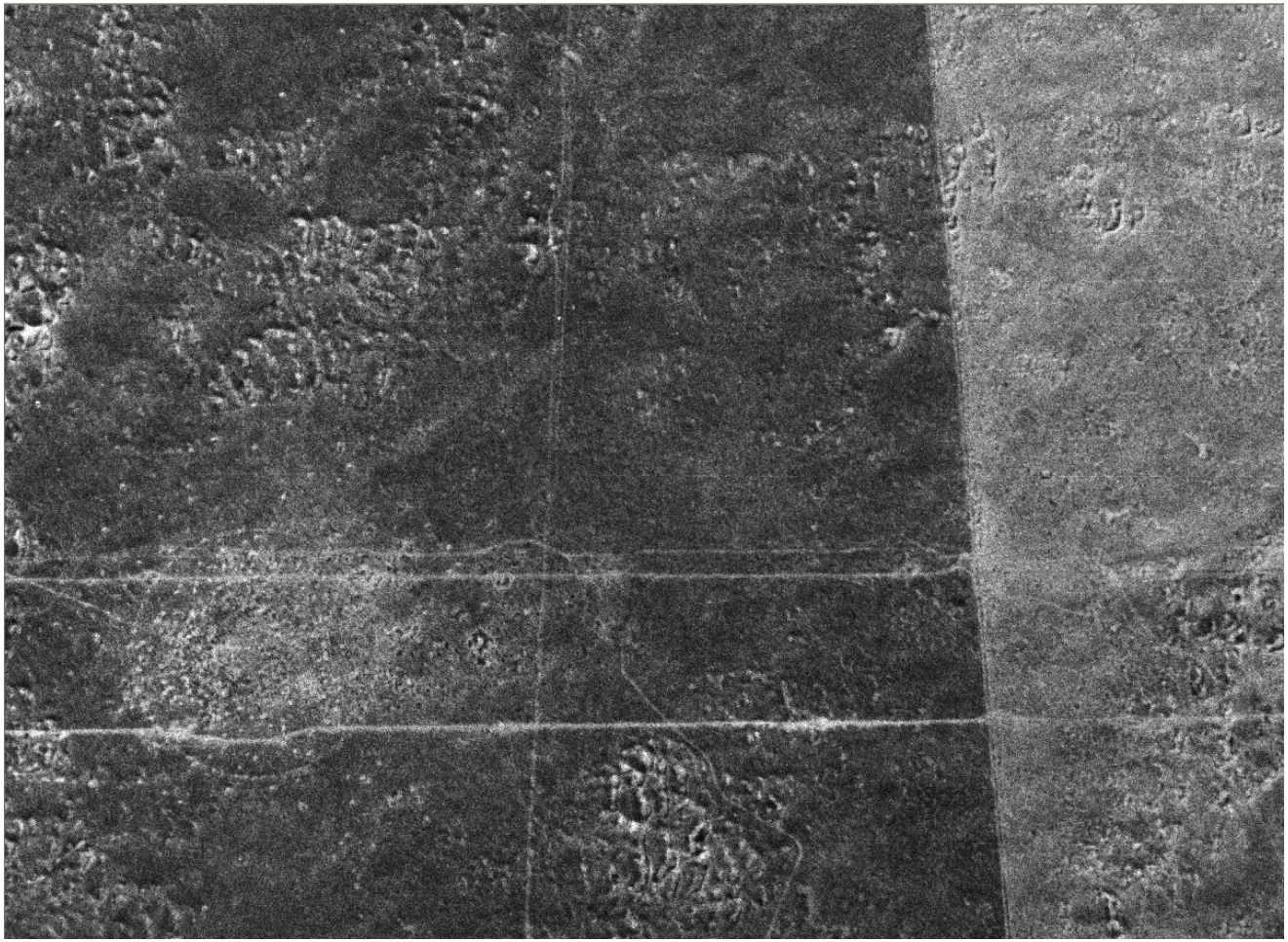
Walker Demolition Range #35 - 1971

(Original Photo Scale 1:24,000)

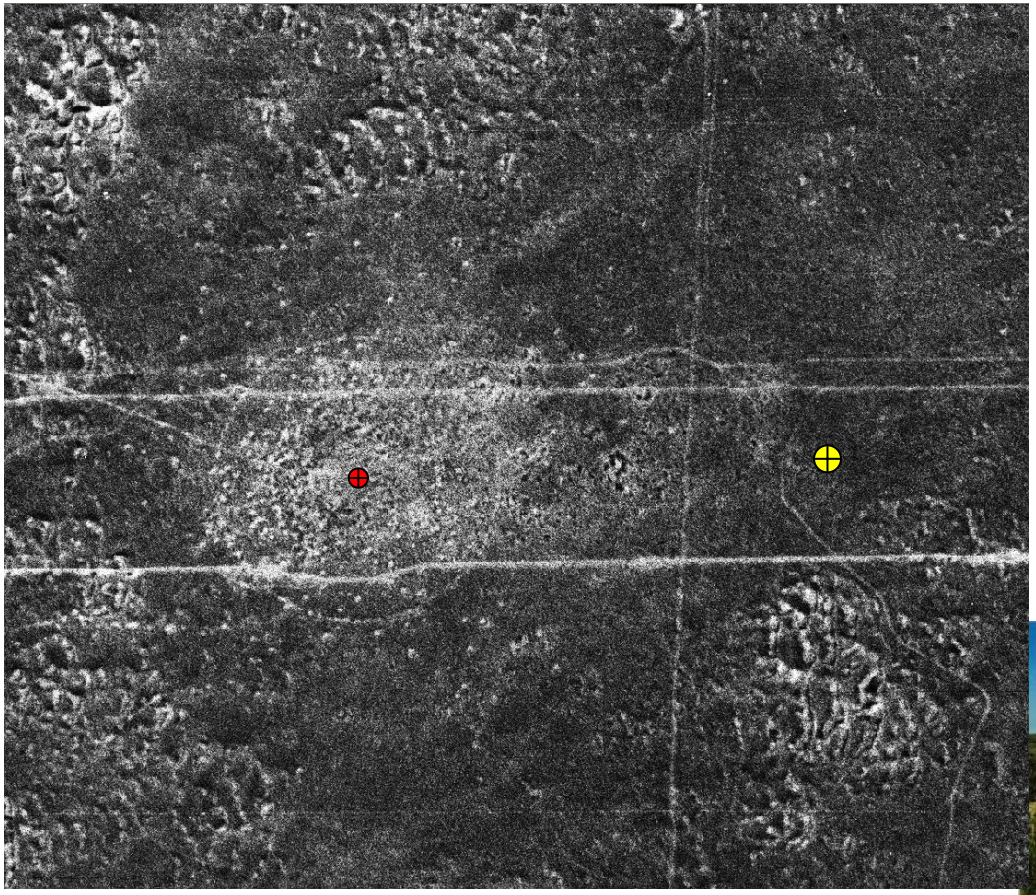


Walker Demolition Range #35 - 1954

(Original Photo Scale 1:63,000)



Walker Demolition Range #35



1954 Enhanced 1:63,000 Scale Photo

K06NM0499

Actual Target Center (⊕) Appears Nearly 1,600 Feet West of the Field GPS Mapped Location identified as "Target Center" (⊕)

Wide Area Assessments

- Historical photos should be routinely used as a cost-effective baseline component of Wide Area Assessments (WAA).

- Kirtland site (K06NM0445) had only partial photo interpretation assessment for 1994 ASR using 1967-1970 photography.

WEST MESA

ALBUQ Journal 11 OCT 96

Bomb Found Near Airport

Experts Detonate WWII Explosive

BY STEVE SHOUP
Journal Staff Writer

A World War II bomb accidentally dug up by construction workers on a remote West Mesa road was safely detonated in a thunderous explosion Thursday.

No one was injured when the 100-pound bomb was intentionally exploded by bomb technicians where it was found north of the Double Eagle II Airport.

No one knew how the bomb got there, but technicians for the explosive ordnance disposal squad from Kirtland Air Force Base identified it as an AM series GP bomb from World War II, said Sgt. Ben Wyne of the Albuquerque Police Department bomb squad.

The bomb was found around 2:30 p.m. by workers building the Airport Interim Access Road, which links Paseo del Volcan and Paradise Boulevard NW.

Vince DeMenno, owner of DeMenno Construction Co., was running a large front-end loader, helping to build drainage channels.

"We were just moving some dirt and stacking it up and I saw this cylinder fall and thought it was an oxygen cylinder," DeMenno said. "Then I saw some hooks and marks and that Army green and I decided it was something different."

DeMenno said he called a friend who uses explosives in construction. The friend told him it was probably a bomb.

"He said it was (strong) enough to take out a pickup truck," DeMenno said.

APD and Kirtland bomb technicians moved the bomb into a 3-foot deep pit that had been dug near the road. With Albuquerque Fire Department, Albuquerque Ambulance personnel, bomb technicians and construction workers standing by about 100 yards away, the APD bomb squad detonated the 50-year-old bomb minutes before 5

See BOMB on PAGE 2

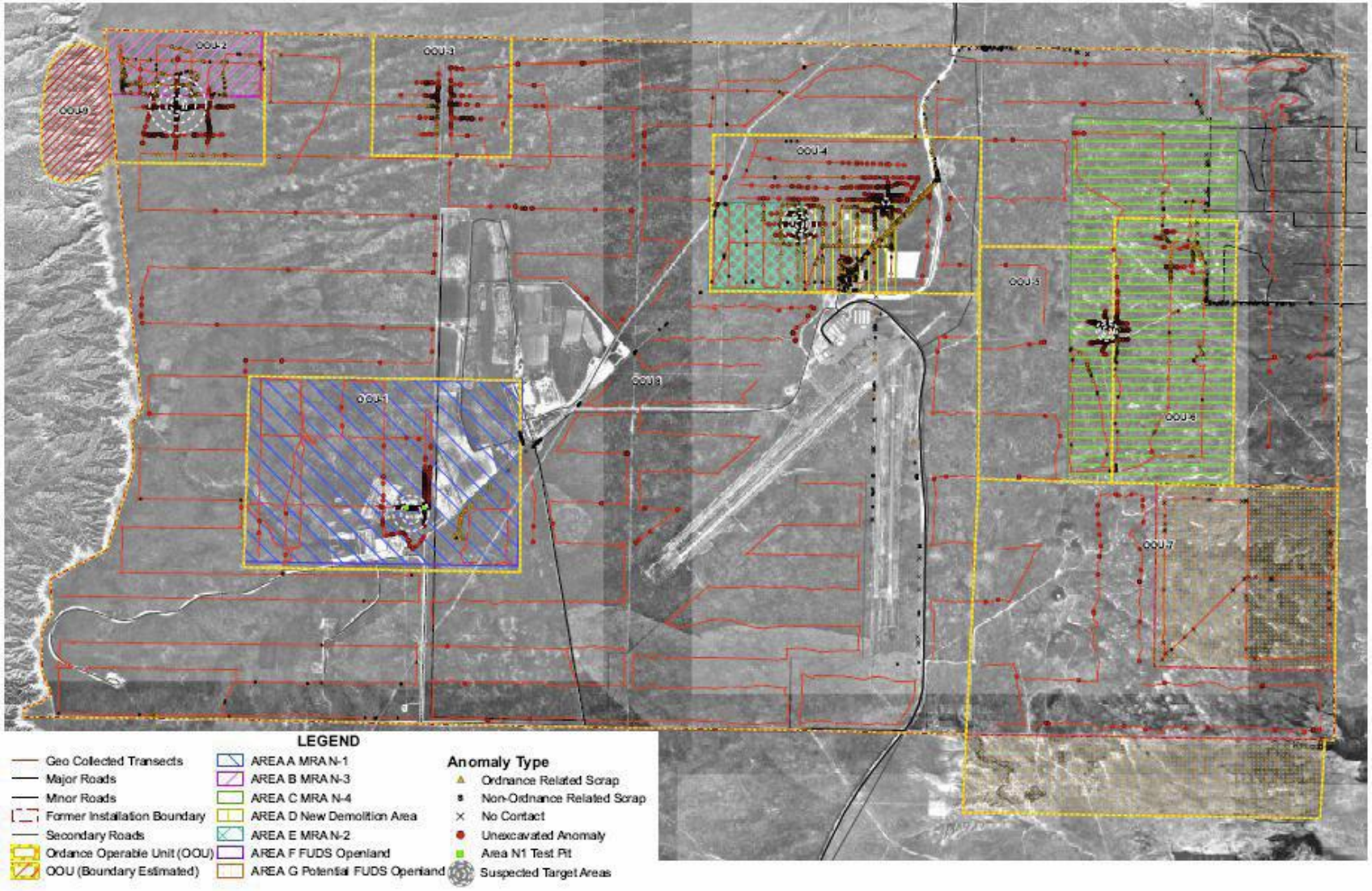
DON ARMSTRONG/FOR THE JOURNAL

THUNDEROUS END: A World War II bomb was detonated by technicians Thursday. The explosive was found by construction workers north of the Double Eagle II Airport.

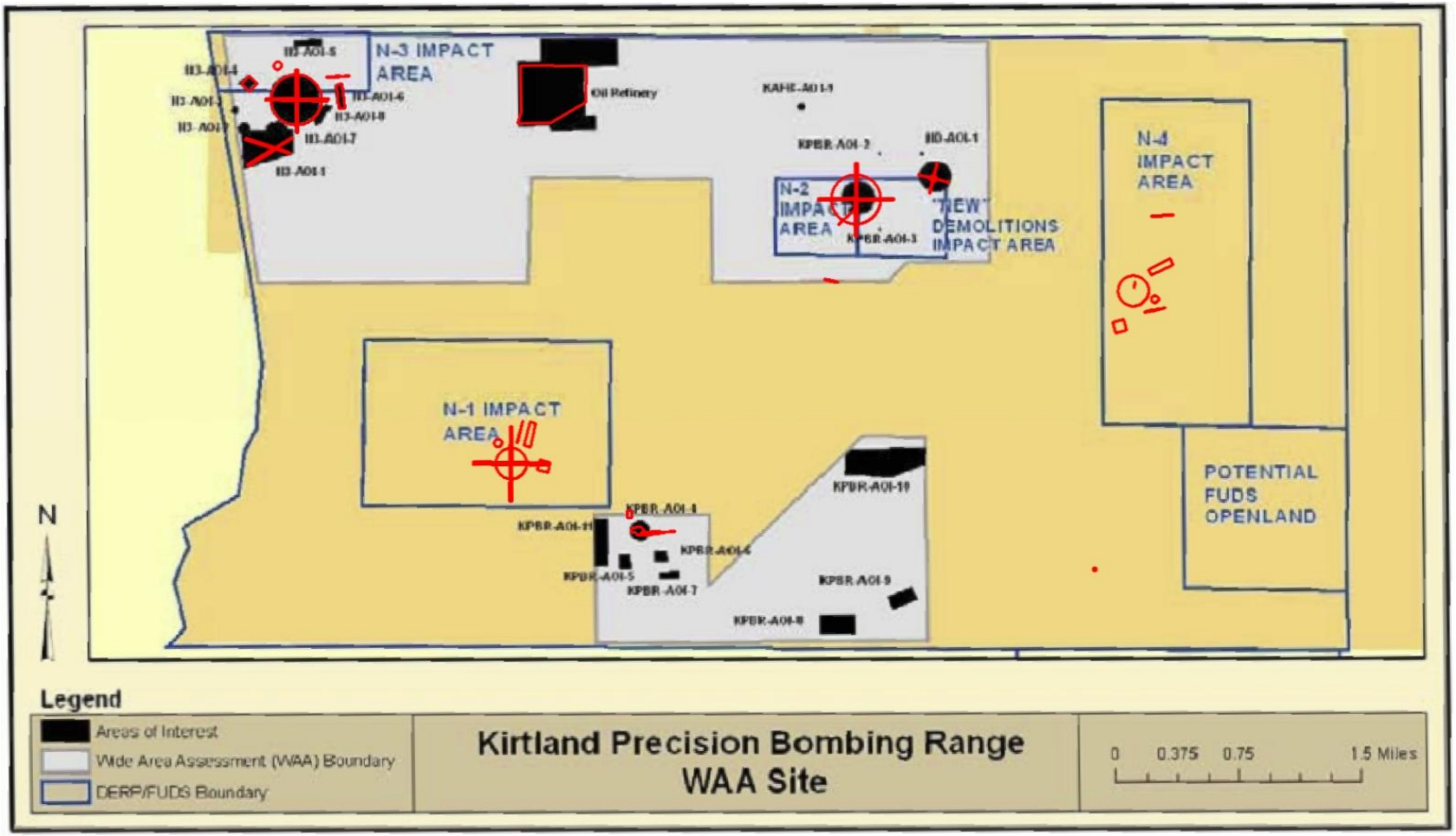
200-1f

K06NM044501_08.08_0002_p

2006 Engineering Evaluation and Cost Analysis

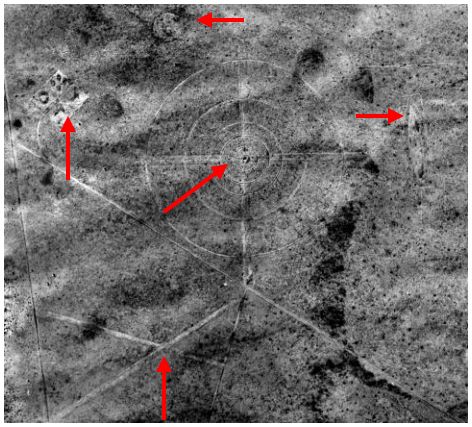


2008 WAA and Ongoing RI/FS Study

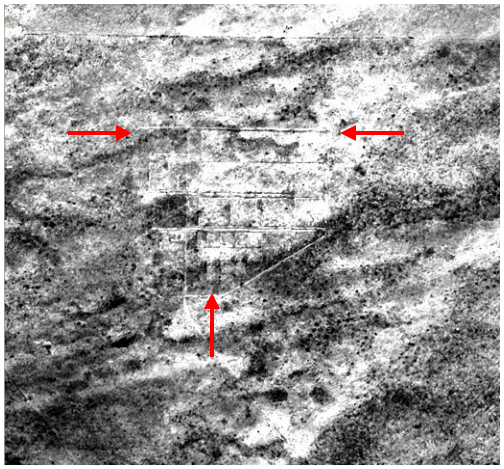


ESTCP Range Features Mapped from 1945 and 1951 Photos

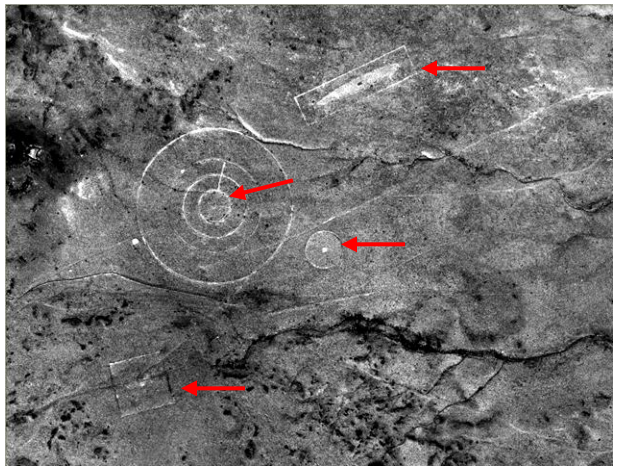
Kirtland PBR's – 1951 Photography



N-3



Simulated Oil Refinery Target



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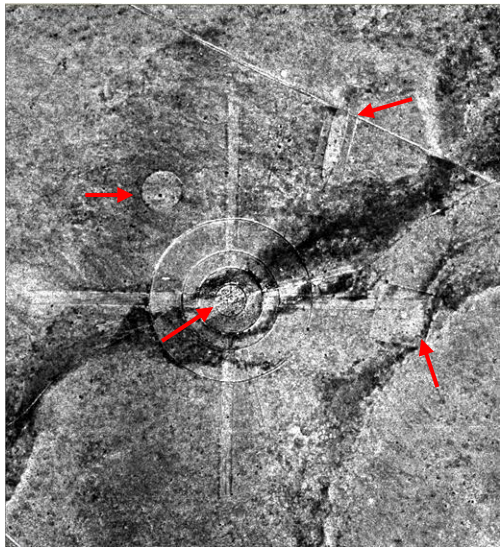
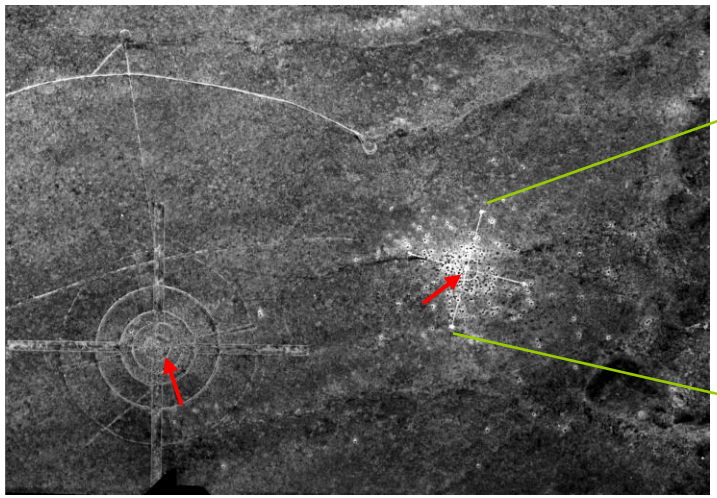
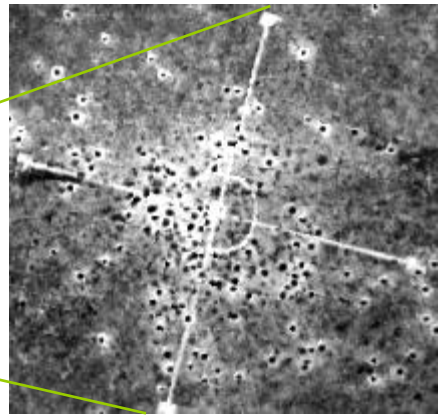


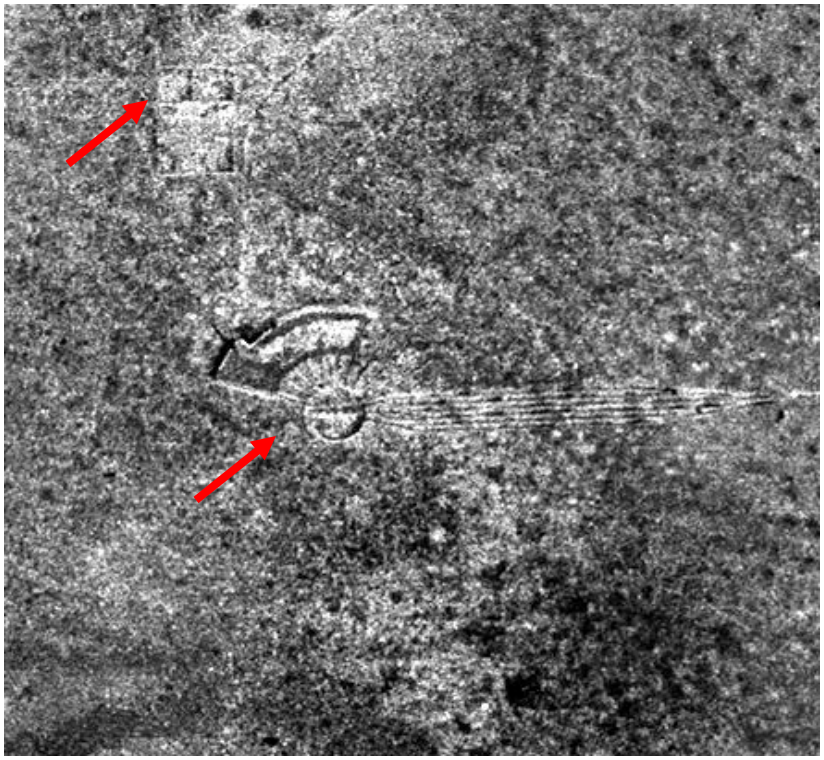
N-1

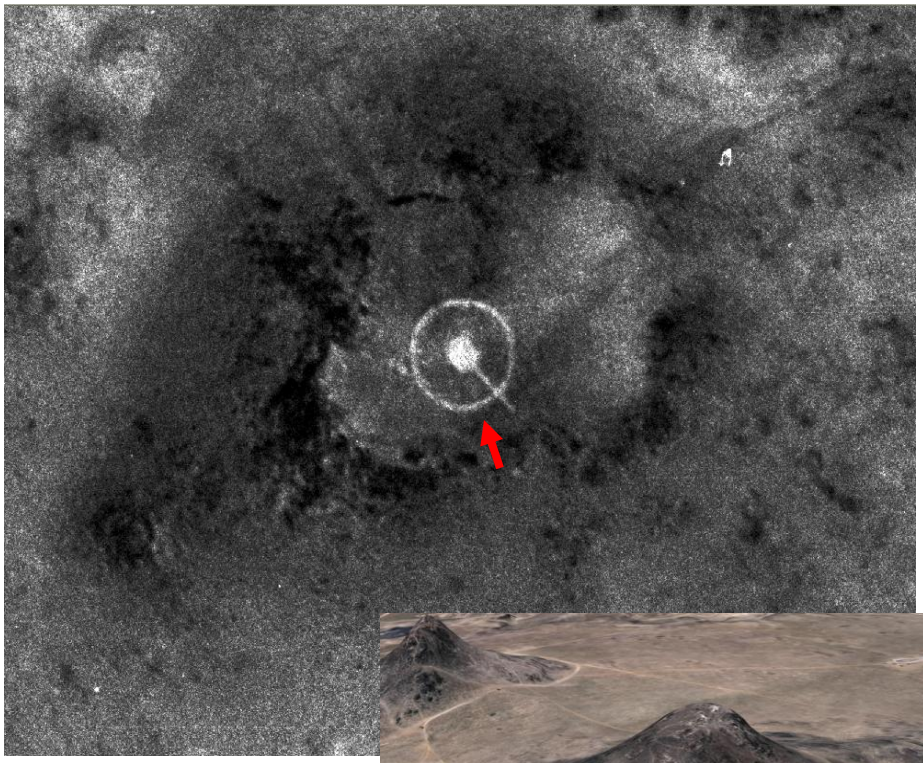




N-2 "New Demolition"

Kirtland – 1951 Photography

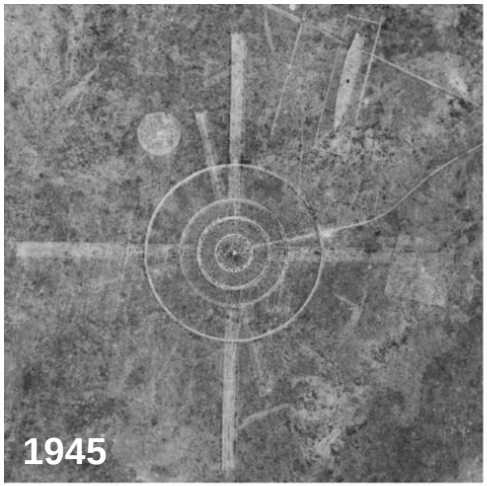


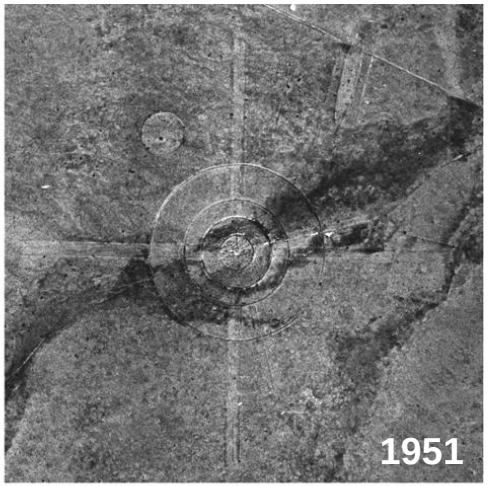


Plus Newly Identified Range Features

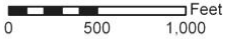
Range Features Through Time

Operational Period for Site Use as Bombing Range

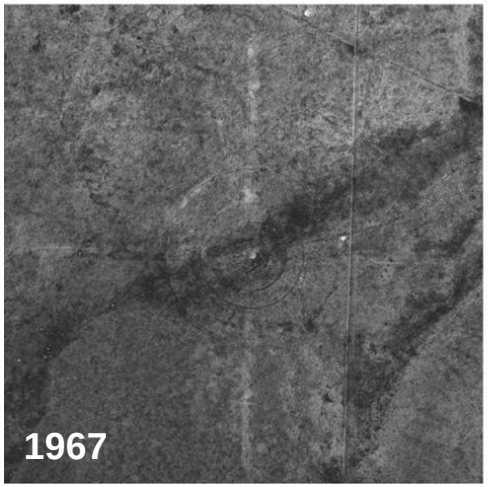


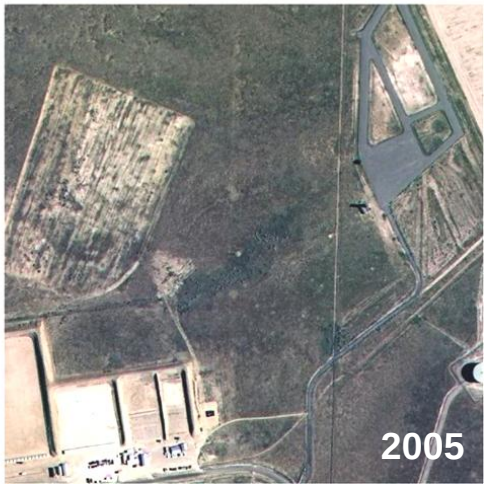


6 Years Later Most – but not all - Features Still Evident



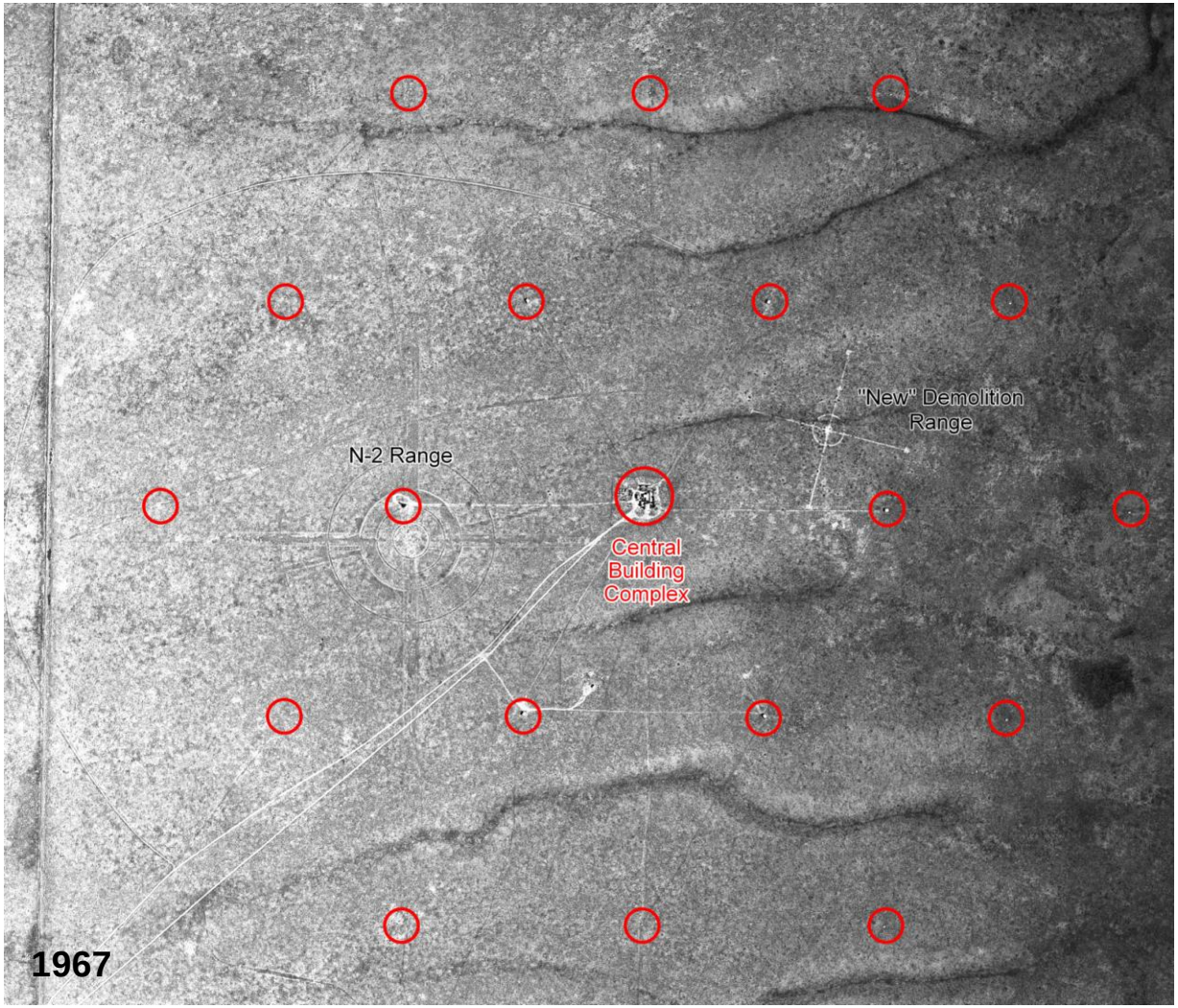
Timeframe of Photos Cited in ASR





Some Features Remain Marginally Apparent

Later “False Alarm” Features



Use of later dates of photos can resolve some interpretation “false alarms”.

The hexagon pattern layout shown is for a facility developed over the N-2 practice and New Demolition bombing ranges.

Original Photo 1:26,000

Photo Archives Going Digital

- Film shelf life varies by type and environment
  - Early cellulose nitrate was highly flammable
    (replaced with cellulose acetate “safety film”)
  - “Vinegar Syndrome” deterioration remains a major archive concern
- Conversion to digital allows use of simple to advanced image processing techniques
  - Simple brightness/contrast and sharpening is very effective
  - Stereo-viewing requires more complex equipment and software but is rapidly advancing
  - Geo-referencing (registration or ortho-correction) improves utility
- Conversion to digital involves scanning quality issues
  - Photogrammetric versus Graphics versus Consumer quality
  - Scanning Resolution: recommend ~ 1800dpi for film, ~1200dpi for print

Summary

- Use of historical film diapositives and digital analysis techniques can result in improved range and target feature interpretations.
- Historical photo searches often need to be more extensive and periodically updated – photo search results are not static!
- Image registration or full ortho-correction provides a useful basis for analysis and use of historical photos in Geographic Information Systems.
- Comprehensive historical photo analyses provide a cost-effective baseline component for any Wide Area Assessment (WAA) of World War II era Bombing Ranges.

US Army Corps of Engineers

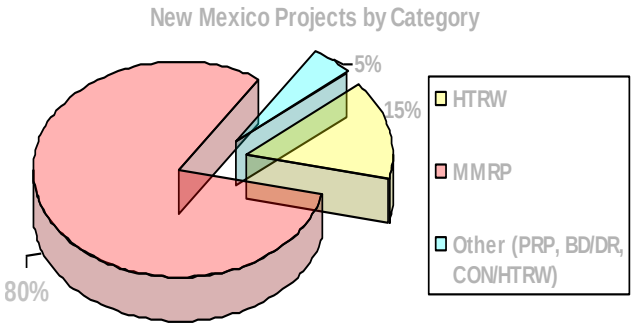
TerraSpectra GEOMATICS

BACKUP MATERIAL

Background

- **Army Corps of Engineers Albuquerque District FUDS Program GIS Support:**

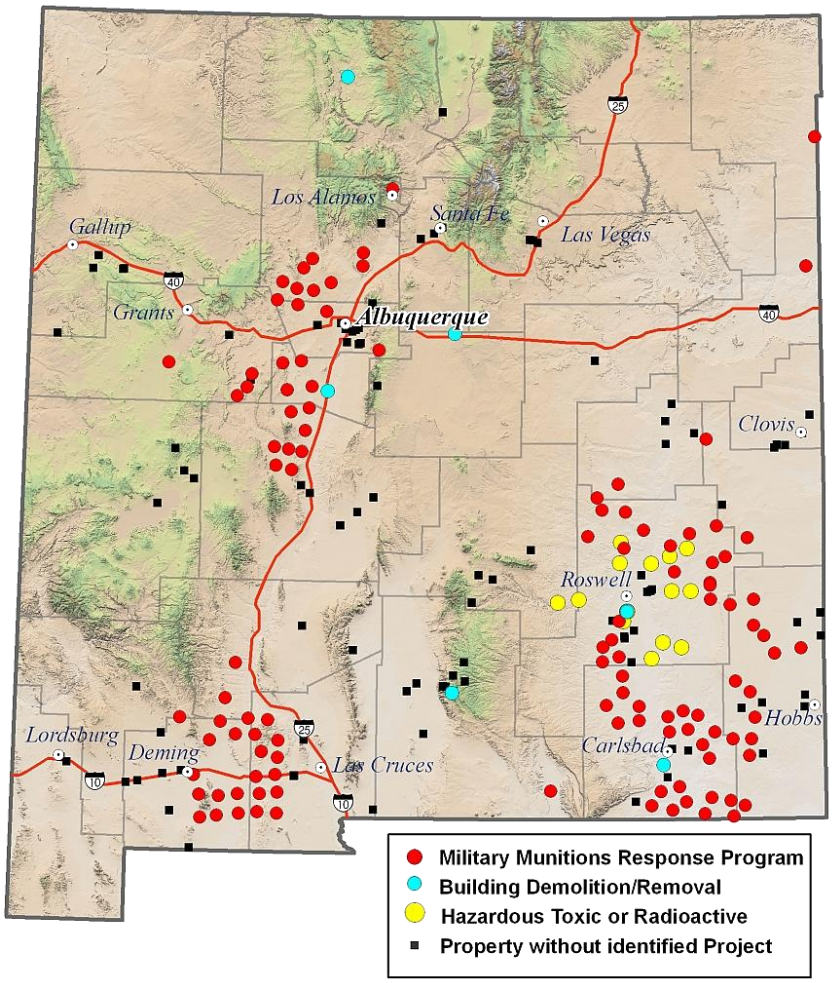
  255 New Mexico FUDS Properties*
  147 NM FUDS Projects



- **118 Military Munitions Response Program (MMRP) sites**

- **Primarily WWII Practice Bombing Ranges**

NEW MEXICO

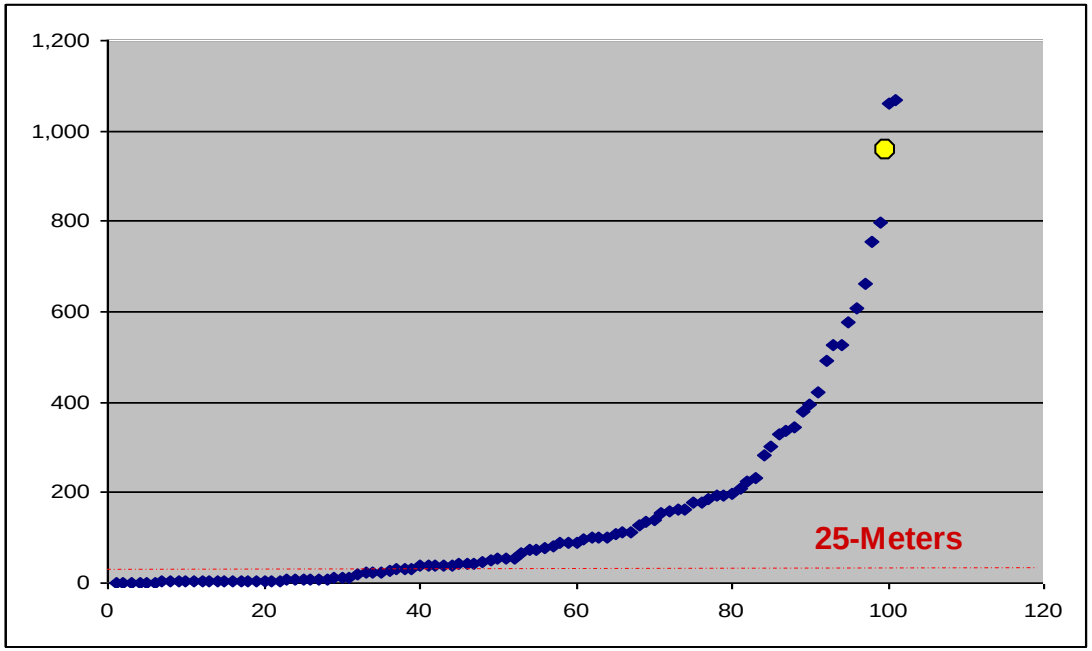


* 2007 status

Orthophoto Adjustments

EPA Locational Data Policy used 25 meters as standard for environmental data accuracy.

Range Location Offsets (meters) ASR/CAD from Recent Orthophoto



Sequential Site Number – Sorted by Offset

1:24,000 Scale Orthophoto Map Accuracy Standard is <10 meters

Edge matching and survey checks indicate 1-3m is typical

Over 65% of NM FUDS MMRP Range centroids checked had apparent offsets >25 meters.

Interactive Deconvolution

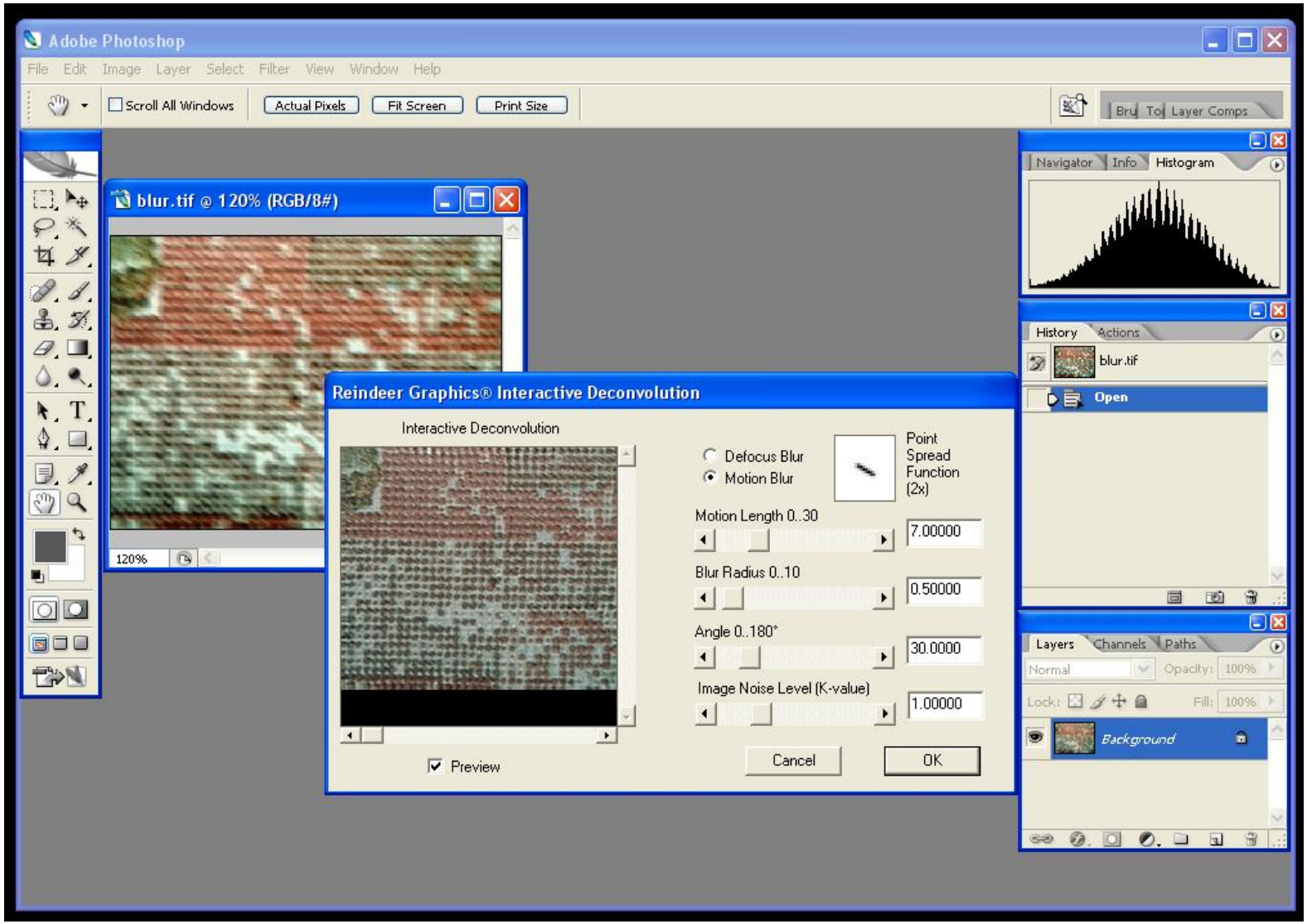
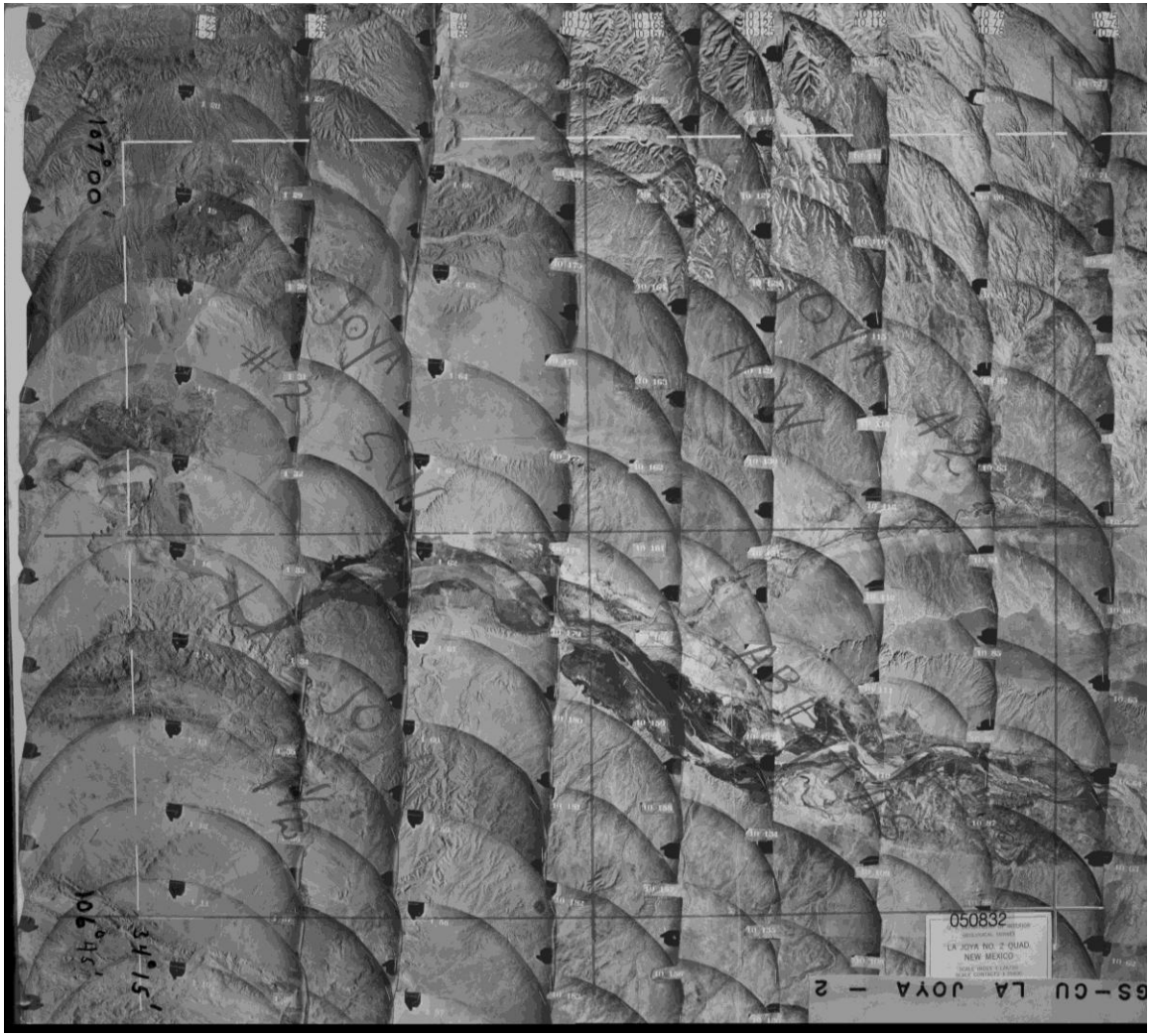


Photo Coverage Availability



Example Photo Index for Acquisition Series

Not all Photos are Individually Indexed for Computer Search by Coordinates

1946 photo index

Kirtland AFB PBR #18 Target S-5

1946 Photography

Photo Scale 1:34,500

K06NM0619

Kirtland AFB PBR #18 Target S-5

Range Target Circles and Perimeter Fence Line are Distinct

Site was originally mis-located based on Public Lands Survey System (PLSS) legal description and range was not mapped

Subsequent PA has used this 1946 photo and mapped range

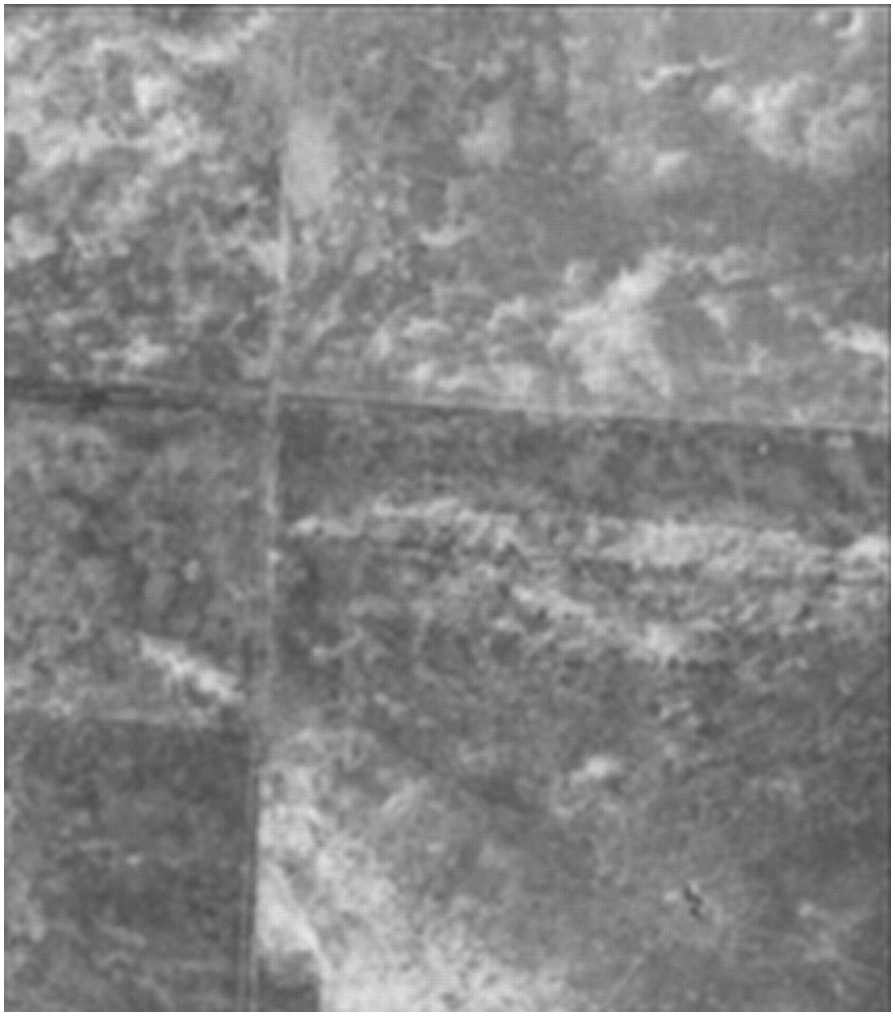
K06NM0619

Scanning Resolution

USGS-EDC Photogrammetric Scanner
3629 pixels per inch (7 microns)

1954 Photo for K06TX0267
Photo Scale: 1:64,000
Dalhart PBR #3 & #4

Scanning Resolution



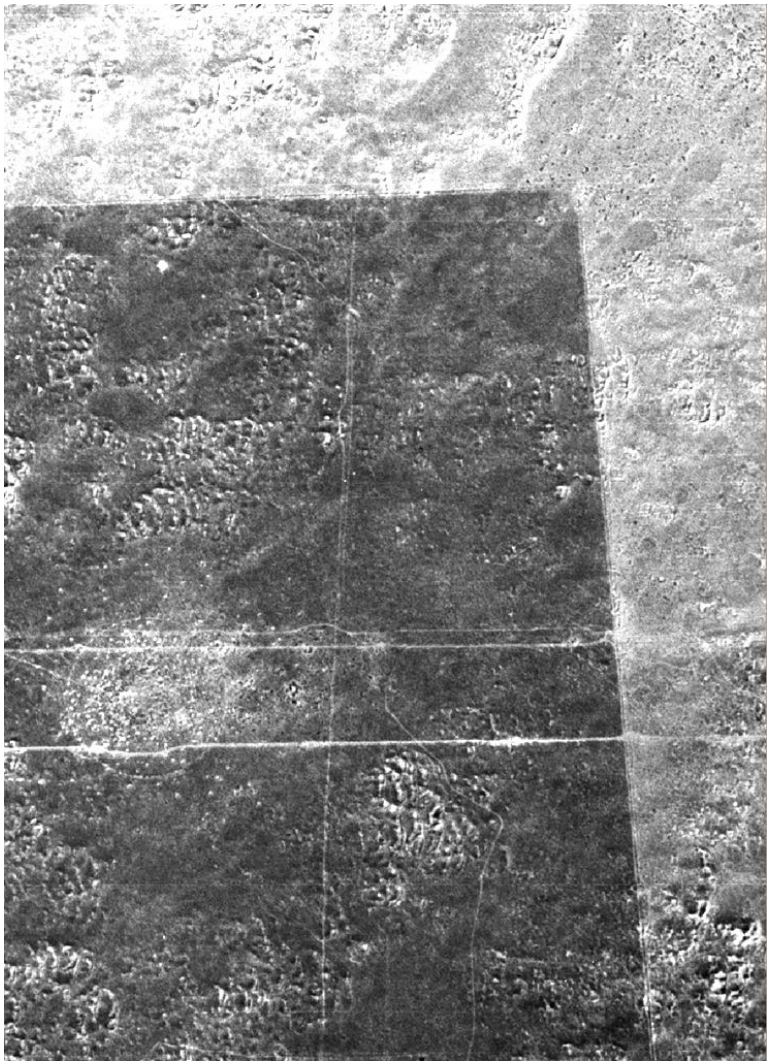
USGS-EDC
New Standard 9/1/09
1000 pixels per inch
(25 microns)

Imagery will be available online at no cost

1954 Photo for K06TX0267
Photo Scale: 1:64,000
Dalhart PBR #3 & #4

Walker Demolition Range #35

1971 Photo Used for ASR (1:24,000)



1954 Photo (1:63,000)